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# BOTANICAL GAZETTE

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## OBSERVATIONS ON *POLYPORUS LUCIDUS* LEYS, AND SOME OF ITS ALLIES FROM EUROPE AND NORTH AMERICA<sup>1</sup>

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(WITH FIVE FIGURES AND PLATE XIX)

The close relationship between the fungus flora of Europe and North America has long been recognized. There are many species which are common to both countries. This in a large measure is due to the same general conditions which have long been recognized in explaining the similarity between the spermatophytic floras of the two countries, namely, the strong evidence presented by certain geologic periods that many centuries ago the two floras were contiguous in the arctic regions, at a time when the climate there was mild enough to permit the growth of those species and genera, contributing through their progeny the present representatives, which have survived the climatic and edaphic rigors to which they were subjected during the subsequent glaciation of the arctics, and the shifting glacial movement farther to the south. The fungus flora of a country bears a very close and important ecological relation to other plants, especially to the spermatophytic flora, whether as parasitic, humus-dwelling, or wood-destroying species. They are "camp followers" of the higher plants. Because of this symbiotic and metabiotic relation of the fungi to other plants, in a great measure their lodging and migration is coincident with that of their hosts. In the case of the forest fungi there are some interesting examples of tenacious adherence to specific hosts, or to descendant species which have become separated in the migratory movement from the parent

<sup>1</sup> Contribution from the Department of Botany, Cornell University, No. 130.

stock. There are also interesting examples of a shift from one host to a host of another related genus, instead of to a species of the same genus, where in the migration the specific hosts are not evenly distributed over the area of general migration from a given region. *Pleurotus ulmarius* Bull., while occurring on other frondose trees, is more common on the elm both in Europe and North America, although our native species of elm is different specifically from the European elm. *Annularia fenzlii* Schulz. was first collected in Hungary on *Tilia europaea* and does not seem to be common or widely distributed in other parts of Europe. It has been collected once at Ithaca, N. Y., on our native species of basswood, *Tilia americana*. *Fomes fraxineus* (Bull.) Fr. seems to be confined to the ash, occurring on the European ash in Europe and on our native species in the United States. *Fistulina hepatica* (Huds.) Fr. occurs in Europe especially on the oak, but sometimes on beech and chestnut. In North America it occurs most commonly on the chestnut, but is reported also on the oak, European species of oak not occurring naturally in this country. Many other similar examples might be enumerated. In a number of cases the fungus species seems to have undergone little or no change, although now separated for centuries on two different continents and subjected often to widely different environmental conditions. In other cases the North American representative of European species seems to have undergone a change, whether gradual or sudden we cannot say, so that it presents certain constant characters worthy often of specific separation, while resembling in a striking way the European species.

One of these interesting problems is presented by *Polyporus lucidus* Fr.<sup>2</sup> (*Boletus lucidus* Leys.<sup>3</sup>). My first acquaintance with what appears to be the typical form of *P. lucidus* in Europe was in the autumn of 1903, when I collected a specimen growing from the root of a dead frondose tree in the Bois de Boulogne, Paris. Two years later, while visiting M. E. BOUDIER at Montmorency, near Paris, he gave me a fresh young specimen which had been sent him from one of his numerous correspondents in France. It is a large and handsome fungus, varying considerably in size and form. The typical forms are stipitate, with a lateral pileus. In these forms

<sup>2</sup> Flora Halensis 300. 1783.

<sup>3</sup> Syst. Myc. 1:353. 1821.

the stipe is usually quite fully developed before the formation of the pileus, the latter developing gradually as a lateral extension of the free end of the stipe and becoming dimidiate, reniform, or flabelliform, usually with an entire margin, but sometimes more or less



FIG. 1.—*Ganoderma pseudoboletum* (Jacq.) Murrill (*Polyporus "lucidum"* Leys.) (natural size), from France.

crenate or rarely somewhat lobed. Sometimes the pileus is nearly sessile, the stipe being reduced to a stout tubercle, especially when the plants grow directly on the side of a log. The plants occur singly or in clusters, and sometimes imbricated. One of the striking characters, which is also a peculiarity of a number of other species,

is the formation of a colored viscous substance on the surface of the stem and pileus which dries and hardens into a smooth, hard, thin, lustrous crust or "skin," which gives the plants a varnished appearance. In typical forms of *P. lucidus* this is a reddish chestnut, or *marron* color, varying to darker colors or even blackish in some forms of the species. The surface of the pileus is often marked by concentric rings and furrows, usually not very pronounced, and usually toward or on the margin where the rings are often close together. The surface is often radiately rugose. The pileus varies from 2–25<sup>cm</sup>. or more in diameter and 1–4<sup>cm</sup> thick behind. The stipe varies greatly in length, and from 0.5–4<sup>cm</sup> in diameter. The tubes are long and slender, brown within, the mouths circular, angular, white or yellowish, finally yellowish brown, with the dissepiments thin and acute. The trama or context of the pileus is pallid to brown, the portion next the tubes being darker brown, about the same color as the tubes, while it is paler to almost white next the varnished crust. The context of the stem is brown, with more or less distinct transverse concentric zones, which are also found to some extent in the pileus, and there is a distinct radiating fibrous structure extending into the pileus. The context is also soft and "punky."

Before the plant is mature, and while it is in different stages of development, the growing end of the stipe and the growing margin of the pileus are whitish, then changing to reddish yellow and finally chestnut as the varnishing becomes complete.<sup>4</sup> BULLIARD<sup>5</sup> and GILLET<sup>6</sup> figure young plants showing the lighter-colored margin. This condition is different from the yellowish unvarnished condition of the pileus of *P. curtisii* Berk.<sup>7</sup> from the southern United States, with which MURRILL<sup>8</sup> compared BULLIARD'S and GILLET'S figure.

The fact that the typical form of *P. lucidus* occurs in Europe on frondose trees lends additional interest to the most common form of this species in the United States, which occurs on the hemlock-

<sup>4</sup> See EDGERTON, C. W., The rate and period of growth of *Polyporus lucidus*. *Torreya* 7:89–97. 1907.

<sup>5</sup> *Boletus obliquatus* Bulliard. *Herb. de la France*. pl. 7, fig. A, pl. 459, figs. B, C. 1880–1890?

<sup>6</sup> *Polyporus lucidus* Fr. Gillet. *Champignons de la France* 666.

<sup>7</sup> *Polyporus curtisii* Berkeley. *Hook. Jour. Bot.* 1:101. 1849.

<sup>8</sup> Bull. Torr. Bot. Club 29:604. 1902.

spruce (*Tsuga canadensis*). This form can be distinguished from the typical form on frondose trees in Europe only by the fact that it

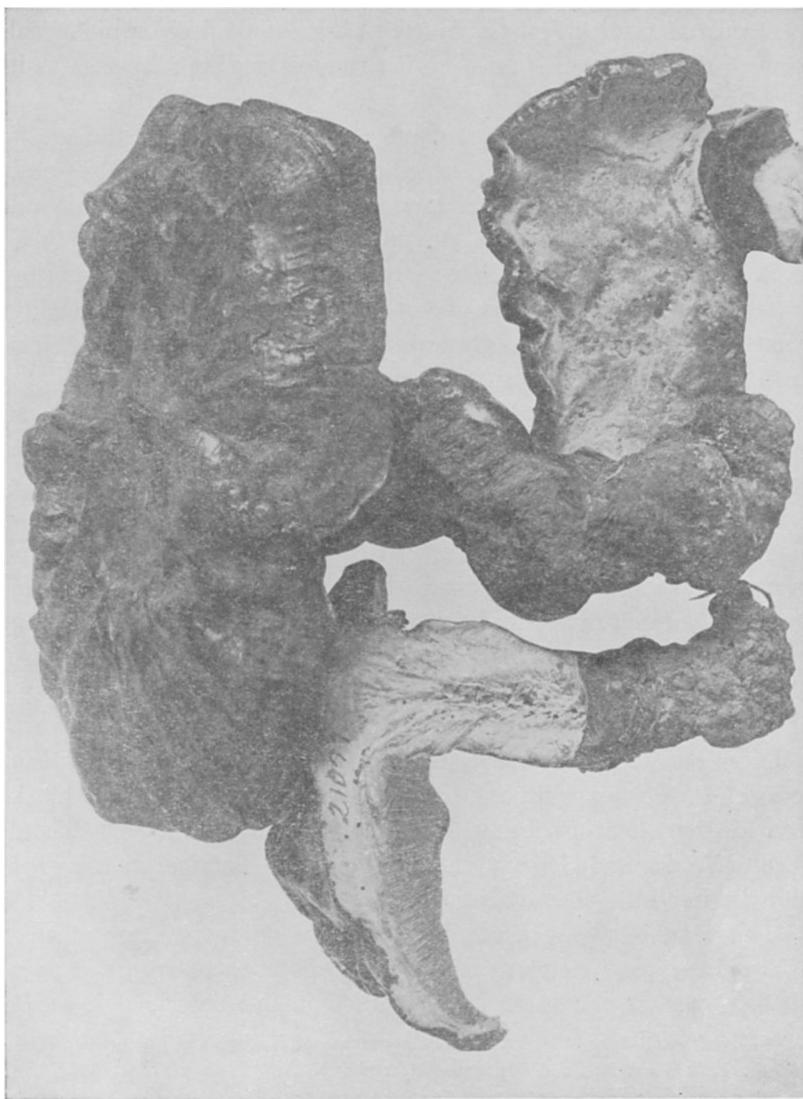


FIG. 2.—*Ganoderma pseudobolletum* forma *montanum* Atkinson (X4), on dead spruce, Jura Mts., France.

grows on a conifer, the hemlock-spruce, rather than on frondose trees, and perhaps by its somewhat softer and perhaps slightly lighter-

colored context, and the longer persistence of the individuals of the European form, since this usually does not disintegrate so soon. But these characters vary in individual plants and seem to mark our form on the hemlock-spruce merely as a physiological or biological form of the European species, rather than as a distant species as it is regarded by MURRILL<sup>9</sup> (p. 606).

*P. lucidus* is rarely reported on conifers in Europe, though it probably is common enough in certain of the mountainous regions. KARSTEN<sup>10</sup> reports it on *Abies excelsa* in Finland. In 1905 I found it quite common in the Jura Mountains<sup>11</sup> near Pontarlier and Boujeailles, Province Doubs, France, on dead stumps and logs of the common fir (*sapin*) of that region. These plants, while showing great variation in form, do not depart in this respect from the typical form. The stem varies from lateral to central in some individuals. There is, however, a marked difference in color, the Jura specimens on the fir having the varnished surface darker in color than those which I have seen from frondose trees in Europe, but also darker than our form on the hemlock-spruce, the color being a dark mahogany red, finally becoming nearly black. The color of the context is brownish like that of the typical form. So far as I could observe, I could see no evidence that this form is perennial, nor have I seen perennial specimens of the typical form. I sent specimens of these plants collected on the fir in the Jura Mountains to M. E. BOUDIER, of Montmorency, and at the same time some of the American form collected on the hemlock-spruce. The latter he pronounced a typical form of *P. lucidus*, while the former he regarded merely as a black form of the same species, which he says grows in the Vosges and Jura in France and Germany. The spores are identical in structure and size in all the above-mentioned forms.

The form in the southern United States on roots, stumps, etc., of frondose trees, seems to be distinct enough to be regarded as a distinct species. BERKELEY so regarded it and described it as *P.*

<sup>9</sup> *Ganoderma tsugae* Murrill. The Polyporaceae of N. Am. I. The genus Ganoderma. Bull. Torr. Bot. Club 29:599-608. 1902; N. Am. Flora 92:118. 1908.

<sup>10</sup> KARSTEN, P. A., Myc. Fenn. pars tertia, Basidiomycetes, in Bidrag till Kändedom af Finlands Natur Och Folk 25:254. 1876.

<sup>11</sup> The collection and study of this material, with many other European fungi, was made possible because of a grant from the Botanical Society of America.

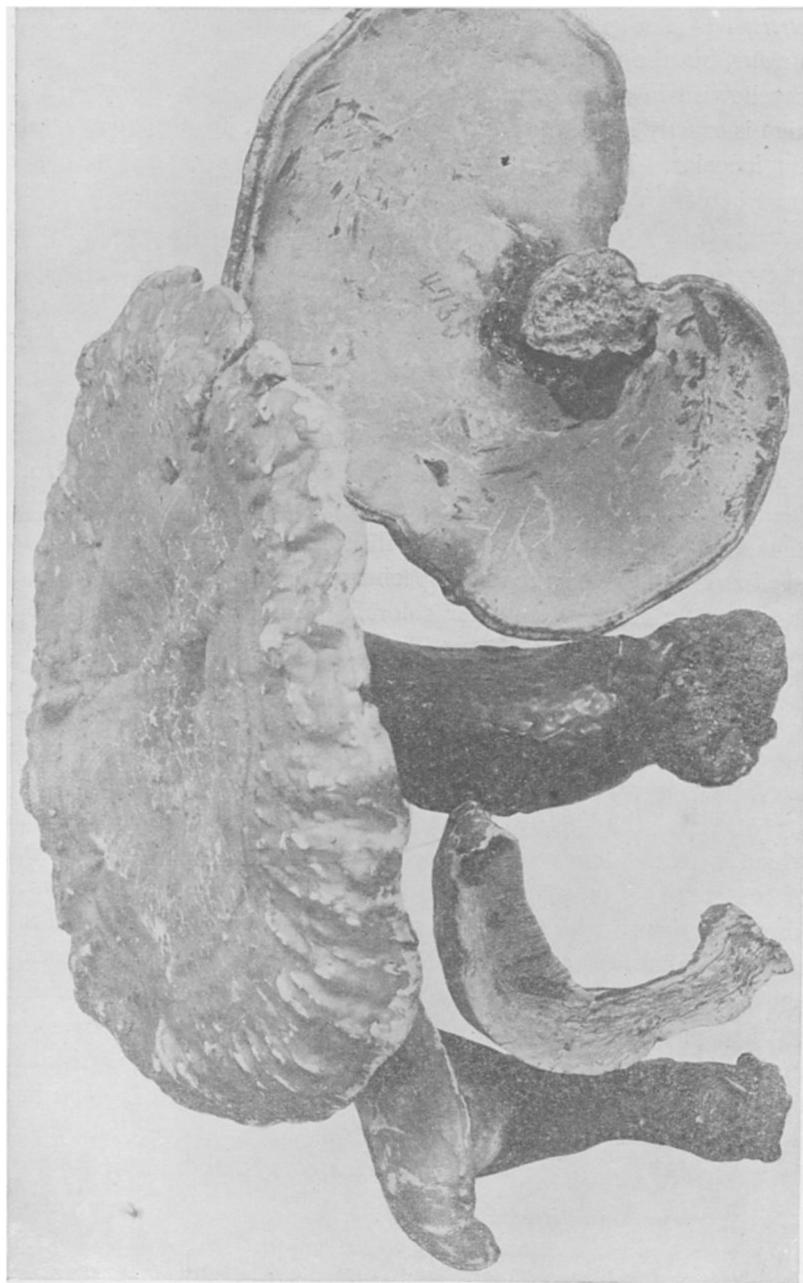


FIG. 3.—*Ganoderma curtisii* (Berk.) Murrill; central plant from Texas, others from North Carolina.

*curtisii*.<sup>12</sup> The general form of the plant is the same as that of *P. lucidus*, but the pileus is rarely and then only slightly varnished, and is yellowish in color, or with reddish-yellow spots and zones. The stem is exactly like that of *P. lucidus* and is varnished, reddish chestnut in color. In the extreme south forms with a central stem are more common, and then the pileus is more or less depressed in the center, as in fig. 2, which represents a specimen collected in Texas by A. M. FERGUSON. The surface is often zonate, faintly or strongly sulcate, and sometimes radiately rugose or corrugated toward the margin. While MURRILL first considered this as merely a geographical form<sup>13</sup> of *P. lucidus* (*Ganoderma pseudoboletus* Murr.), he now treats it as a distinct species<sup>14</sup> (*G. curtisii* [Berk.] Murr.).

Another form which has come under my observation was sent me by Mr. M. E. HARD, of Chillicothe, Ohio, who collected it from dead buried roots of oak, growing among *Datura stramonium*. These plants (fig. 5) resemble the typical European form in color and consistency. These individual specimens were not fully grown, and therefore the margin is lighter colored. The pileus as well as the stem is laccate or varnished. There are some differences in the spores which will be discussed below.

Another interesting form was received from E. R. LAKE, of Corvallis, Oregon, in January, 1905. It is a large stipitate plant with a lateral pileus, the pileus measuring 14<sup>cm</sup> long by 12<sup>cm</sup> broad and 5.5<sup>cm</sup> thick. The pileus is tumid and covered with a thin crust, which is brittle, dark reddish brown, and laccate, similar to the crust of the stem. The context of the stem is also white and shows a fibrous structure which radiates out into the pileus. The tubes are slender, cinnamon brown, and 2-5<sup>cm</sup> long. The plant was growing apparently on burnt ground from a root, probably of some conifer. In this specimen the varnished crust of the pileus extends over the under side of the margin and over the hymenophore for a distance of 0.5-1<sup>cm</sup>, and a new stratum of tubes 4<sup>mm</sup> in length is deposited over the remaining portion of the hymenophore. In sections of the hymenophore this stratum tends to break away rather easily from its

<sup>12</sup> *Polyporus curtisii* Berk. Hook. Jour. Bot. 1:101. 1849.

<sup>13</sup> Bull. Torr. Bot. Club 29:602. 1902.

<sup>14</sup> N. Am. Flora 9<sup>2</sup>:120. 1908.

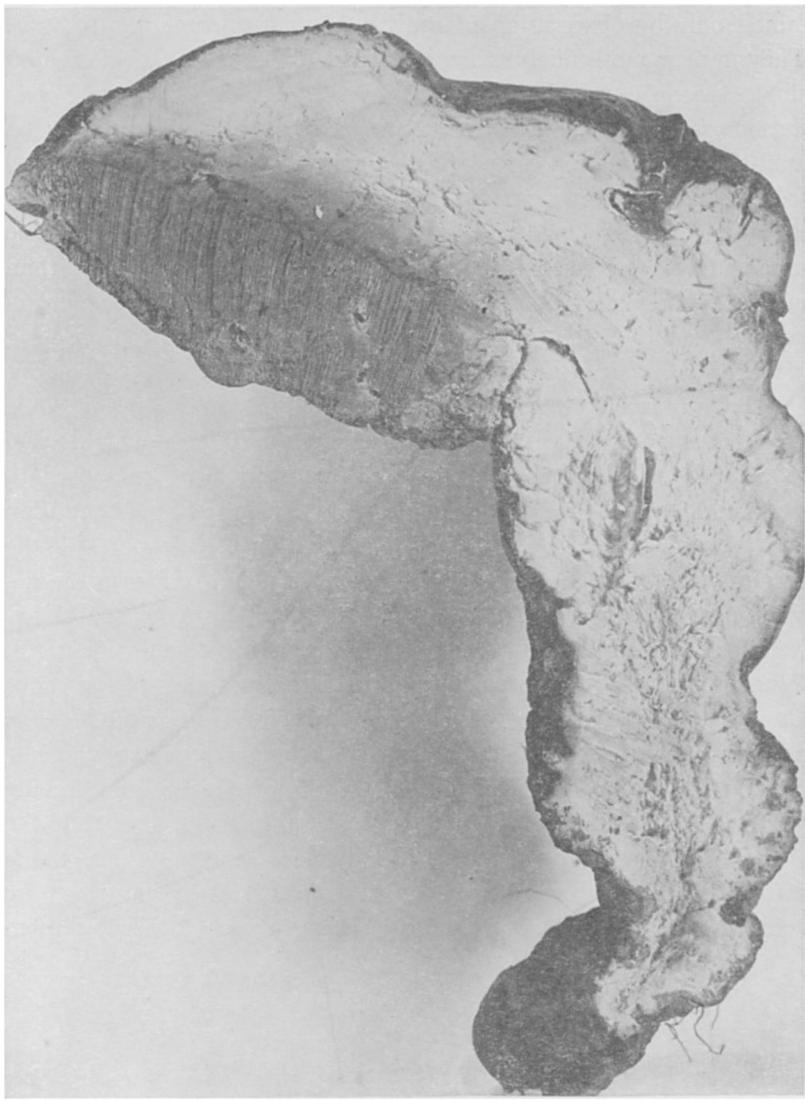


FIG. 4.—*Ganoderma oregonense* Murrill, from Corvallis, Oregon (natural size).

point of attachment with the older portion. There is also a faint stratification of the main portion of the hymenophore, but whether this is due to successive annual layers is doubtful, and can be deter-

mined only by observation of individual plants from year to year. They appear more likely to be the result of periodic variations in a single season's growth, like some of the similar strata in *Fomes fomentarius*. The plant has the appearance of being normally an annual, which under certain conditions may persist for a second season and develop a second depauperate layer of tubes; or this layer may be developed at the close of the first season, often some unfavorable condition inhibiting the growth for a longer period than usual. It appears to be specifically identical with *Ganoderma oregonense* Murrill,<sup>15</sup> recently described from Oregon as growing on a log of *Picea sitkensis*.

The spores of the species discussed in this paper present some very remarkable peculiarities in form and markings, which seem to have been misinterpreted by all those who have attempted to describe them up to the present time. During the past autumn and winter I have made a critical examination of the spores of the species mentioned above, and have not been able to confirm the descriptions thus far given. KARSTEN in 1889<sup>16</sup> says the spores are warty (sporerna äggrunda eller elliptiska, vörtiga, gulbrunaktiga). PATOUILARD in 1887<sup>17</sup> describes and figures the spores of the genus *Ganoderma* as verrucose (verruqueuses) and cites *Ganoderma lucidum* as one of the typical species. Later<sup>18</sup> (p. 66) this is repeated where he places *Ganoderma lucidum* in the section of *Ganoderma* having verrucose spores (spores verruqueuses). SACCARDO<sup>19</sup> says that the spores of this species are slightly verrucose (forma typica sporis ovoides, leviter verrucosis), and BRESADOLA states that they are verrucose.<sup>20</sup> MURRILL in 1902<sup>21</sup> and again in 1908<sup>22</sup> describes them

<sup>15</sup> N. Am. Flora 9<sup>2</sup>:119. 1908.

<sup>16</sup> Kritisk Ofversigt af Finl. Basidsv. 327. 1889.

<sup>17</sup> Les Hyménomycètes d'Europe 142. pl. 3. fig. 21. 1887.

<sup>18</sup> Le genre *Ganoderma*. Bull. Soc. Myc. France 5:63-83. pls. 10, 11. 1889; see also PATOUILARD, N., Essai taxonomique sur les familles et les genres des Hyménomycètes 105. fig. 58, 3b. 1900.

<sup>19</sup> Sylloge Fung. 6:157. 1888.

<sup>20</sup> Hymenomycetes Hungarici Kmetiani. Atti Acad. Sci. III. 3:73. 1897.

<sup>21</sup> Bull. Torr. Bot. Club 29:601. 1902.

<sup>22</sup> N. Am. Flora 9<sup>2</sup>:118. 1908.

as verrucose in several species (*Ganoderma tsugae* Murrill, *G. lucidum* [Leys.] Karsten, *G. curtisii* [Berk.] Murrill, and others).

In studying the spores of these species I have been surprised to find that they are not echinulate or roughened. The spore wall is smooth, that is, there are no elevated or projecting portions of the surface. But the spores have a very peculiar structure, which re-



FIG. 5.—*Ganoderma subperforatum* Atkinson, from Ohio (natural size).

quires very careful examination to interpret properly, and sometimes the use of the oil immersion lens is necessary to resolve clearly the characteristic structure of the wall. On a first examination of the spores with the dry objective, they appear warty or roughened; but the appearance is so peculiar that I was not content with this definition and sought to determine more accurately the nature of the peculiar structure. When the upper or lower surface of the spore is in the focal plane, the wall of the spore presents the appearance of

being verrucose from the presence of numerous brownish or yellowish-brown points; but when one examines the wall at the middle focal plane, these colored dots are seen not to project beyond the outer surface of the wall, though both above and below the middle focal plane they do appear as echinulations. The structure seemed to be so puzzling that I was led to employ the oil immersion lens (Zeiss apochromatic homogeneous immersion lens, equivalent focus 1.5<sup>mm</sup> and compensation ocular 6). This revealed the true structure of the spore wall. It is hyaline or nearly so, and is perforated with numerous slender rodlike extensions of a brown or yellowish-brown substance, which appear as if they might be projections of the colored content of the spore. These do not extend beyond the outer surface of the wall, and they radiate from the endospore through the hyaline wall. They are especially prominent at the smaller end of the oval spore where the hyaline wall is considerably thicker, sometimes forming a broad conelike cap to the spore.

In order to demonstrate this peculiar structure beyond doubt, photomicrographs were made of four different species and forms, and these are reproduced in *pl. 19*. The spores which were lying so that the middle plane was in focus show very clearly that the wall is smooth, and that it is perforated with these short, dark-colored, rodlike extensions. These are very evident all around the spore, but are remarkably prominent at the apex, especially in those spores where the broad conelike hyaline cap is still intact. Where the middle plane of the spore is not in the focal plane, the spores appear "warty," but this is only an optical illusion. This is especially striking in *pl. fig. 6*, where the middle plane of nearly all the spores was out of focus. For the species from which these photomicrographs were made the reader is referred to the description of figures. The fact that the spore wall is hyaline or subhyaline, and perforated with dark lines, gives such prominence to the latter that they are apt to be taken for warts or echinulations when the examination is hasty. The hyaline portion of the spore wall appears also to be of a less firm consistency than the colored perforations or lines, and if the spores dry at a certain age, perhaps before they are quite mature, the hyaline portion of the wall appears often to shrink or collapse somewhat, thus making the colored points stand out as echinulations,

but a careful examination with the oil immersion lens reveals their true structure.

Besides the markings of the spores of these species, there is another peculiarity which has been erroneously interpreted by those who have tried to describe them. This peculiarity relates to the form of the spore. PATOUILLARD<sup>23</sup> in 1889 describes them as truncate and emarginate at the base (tronquées et échancrées à la base) and in 1900<sup>24</sup> simply as truncate at the base. BRESADOLA<sup>25</sup> says the spores in *Ganoderma lucidum* are obovate, at length truncate at the base (sporae obovatae, demum basi truncatae). MURRILL<sup>26</sup> describes them in several species as follows: "Spores ovoid, obtuse at the summit, attenuate and truncate at the base." But a careful study of the spores shows that exactly the reverse is true. The base of the spore is the broadly rounded end, while the apex is the narrowed, "truncate" end. In *Ganoderma lucidum* (Leys.) Karsten from Europe, including the forms collected by myself on the fir in the Jura Mountains, in *G. tsugae* Murrill and *G. curtisii* (Berk.) Murrill, both from the United States, the spores are all similar and practically identical. They are ovate in form, and when they are lying so that they can be seen in side view, they are seen to be more or less inequilateral, that is, one side is more convex than the other. The place where the spore was attached to the sterigma is at the side of the broad rounded end opposite the convex side. Sometimes a minute angle can be seen here where the sterigma was attached. Boiling the spores in a weak solution of potassium hydrate brings out the entire structure more clearly, and at this point, where the sterigma was attached, the spore wall is very thin, there being a slender channel extending from the endospore almost through the episporule to the point where the sterigma was attached. The treatment with potash, however, is not necessary in order to demonstrate the characteristic structure of the spores described above in these species. An examination of the spores in the plate will show several in which the very thick wall at the apex is still intact and forms a broad conelike cap

<sup>23</sup> Bull. Soc. Bot. France 5:66. 1889.

<sup>24</sup> Essai taxonomique sur les familles et les genres de Hyménomycètes 105. 1900.

<sup>25</sup> Hymenomycetes Hungarici Kmetiani. Atti Acad. Sci. III. 3:73. 1897.

<sup>26</sup> Bull. Torr. Bot. Club 29:601. 1902; N. Am. Flora 9<sup>2</sup>:118, 120. 1908.

on the spore. As the spore matures and dries, this cap in most cases either collapses or breaks off, leaving a "truncate" or "emarginate" end.

The spores of *P. appplanatus* of both Europe and the United States have exactly the same general structure as those of *Ganoderma lucidum* described above, as I shall explain in another paper.

The spores of *Ganoderma oregonense* Murrill have the same structure, but the wall is thinner and the structure is not quite so easy to make out. The form of the spores is also somewhat different, being more nearly elliptical in form, though some are obovate, and they are slightly larger. In the spores from *Ganoderma* received from Mr. HARD, mentioned above as growing on roots of an oak, the peculiarities in the structure of the wall described above for *G. lucidum* and some other species are not well developed, and are demonstrated with difficulty. After several examinations, even with the use of the oil immersion lens, I had nearly come to the conclusion that this species was an exception; but after boiling the spores in a weak solution of potassium hydrate, the brownish perforations of the wall were faintly visible. With some other differences in spore character this species seems to be different from the others. In order to present my interpretation of the different species employed in this study of specimens from Europe and the United States, I will add the following diagnoses.

**GANODERMA PSEUDOBOLETUM** (Jacq.) Murrill,<sup>27</sup> Bull. Torr. Bot. Club 29:602. 1902.

*Agaricus pseudoboletus* Jacq. Flor. Austr. 1:26-27. pl. 41. 1773.

*Boletus rugosus* Jacq. Flor. Austr. 2:44. pl. 169. 1774.

*Boletus lucidus* Leys. Flora Halensis, 300. 1783.

*Boletus obliquatus* Bull. Herb. France. pl. 7. 1780; pl. 459. 1790.

*Polyporus lucidus* Fries, Syst. Myc. 1:353. 1821.

*Polyporus laccatus* Pers. Myc. Eur. 2:54. 1825.

<sup>27</sup> In Jour. Myc. 9:94. 1903, MURRILL uses the combination *Ganoderma flabelliforme* (Scop.) Murrill (*Boletus flabelliformis* Scopoli, Fl. Carnolica 2:466. 1772). It is impossible from SCOPOLI's description to say to what species he referred. SCOPOLI cites fig. 4, plate 37, of BATARRA (Fung. Agri. Armin. Hist. 1755). There are several of BATARRA's figures which resemble *P. lucidus* more closely than the one which SCOPOLI cites. BATARRA in turn cites *Agaricum flabelliforme* Michelii (Nov. Plant. Gen. 118. 1729), which from his own and MICHELI's description evidently applies to some other plant.

*Ganoderma lucidum* Karsten, Rev. Myc. 3: no. 9, p. 17. 1881.

*Ganoderma tusgae* Murrill, Bull. Torr. Bot. Club 29: 601. 1902; North American Flora 9: 118. 1908.

Sporophore large, usually stipitate, rarely sessile, annual, rarely perennial, convex above, concave or plane below; pileus dimidiate, reniform, or rarely circular, margin plane or broadly crenate to lobed; surface smooth, sometimes coarsely radiately rugose, incrusted with a reddish or blackish substance shining like varnish, sulcate, the shallow concentric furrows marking off zones which are often narrow and crowded on the margin; trama or context punky, often quite firm and hard especially next the hymenophore, brown to pallid whitish, whitish above, brown next the hymenophore, zonate especially next the stem, though sometimes faintly; stem when present lateral or excentric or rarely central, long or short, sometimes forked, 0.5–4 cm in diameter, even or irregular, sometimes enlarged below, varnished and colored like the pileus, context colored like that of the pileus or somewhat darker; hymenophore of long slender tubes, brown within, 3–5 to a mm., mouths circular angular, white or yellowish, finally brown, dissepiments entire, obtuse, thin, acute; spores ovoid to ovate, rounded at the base and slightly inequilateral in side view; wall hyaline, smooth, thickened at the apex into a broad conelike cap which usually collapses, leaving the apex truncate or even depressed, everywhere perforate with numerous slender dark-colored lines which radiate from the endospore through the episporule, 9–11 × 5–8  $\mu$ . *Fig. 1.*

A large and attractive plant, very conspicuous because of its brilliant varnished appearance. Common on decaying stumps and trunks of frondose and coniferous trees. There appear to be forms or physiological species in this species. In Europe the form more commonly collected is on frondose trees, and is regarded as typical. The usual color of these is a reddish chestnut.

The forms cannot be well separated into species, though some of them may be regarded as elementary or physiological species or forms. Among these may be mentioned the following:

G. PSEUDOBOLETUM TYPICUM.—On trunks and roots of frondose trees in Europe (also in N. A. ?); color reddish chestnut.

G. PSEUDOBOLETUM TSUGAE (Murrill) Atkinson.—On hemlock-spruce (*Tsuga canadensis*) in the United States and British America. Since the form does not grow on wood of frondose trees in America it may be regarded as a physiological

species. In color and other characters it differs but slightly if at all from the typical form.

G. PSEUDOBOLETUM MONTANUM Atkinson.—On dead trunks of *Abies* in the Jura Mountains. This form is very dark, almost black, much darker than the typical form. Type specimens No. 21007 in herb. Cornell University, and a specimen of the same collection deposited in herb. Museum of Paris. *Fig. 2.*

GANODERMA CURTISII (Berk.) Murrill, North American Flora 9<sup>2</sup>:120. 1908.

*Polyporus curtisii* Berk. Hooker's Jour. Bot. 1:101. 1849.

*Fomes curtisii* Sacc. Syll. Fung. 6:158. 1888.

*Ganoderma pseudoboletus* Murr. p. p. Bull. Torr. Bot. Club 29:603. 1903.

*Ganoderma flabelliforme* Murr. p. p. Jour. Myc. 9:94. 1903.

Fruit bodies large, corky to woody (sometimes perennial?), stipitate or nearly sessile, stipe lateral, excentric, or central; pileus reniform, or circular when the stipe is central, convex or depressed, 0.5–3<sup>cm</sup> thick at base, with a thin hard crust, margin obtuse; surface zonate, faintly or quite strongly sulcate, sometimes radiately rugose or corrugated toward the margin, smooth, yellowish or reddish yellow, often with reddish spots or zones, not or rarely varnished (laccate); trama or context punky to woody, softer above, harder below next the hymenophore, pallid to pale brownish, light colored next the upper surface; margin sometimes sterile for a short distance on the under side; hymenophore of slender tubes 0.5–1<sup>cm</sup> long (or longer), brown in section, pore surface grayish white becoming reddish brown where bruised, tubes 3–7 to a mm., mouths rotund, minute, dissepiments thin, edge obtuse, entire; spores ovoid to ovate, rounded at base and slightly inequilateral in side view; wall hyaline, smooth, thickened at apex into a broad conelike cap, which usually collapses, leaving the apex truncate or even depressed, everywhere perforate with numerous slender dark-colored lines which radiate from the endospore through the episporium, 9–11×5–8  $\mu$ ; stem 1–15<sup>cm</sup> long, 1–3<sup>cm</sup> thick, nearly cylindrical but variable, surface laccate with a reddish-chestnut varnish on the crust, context brown, nearly the same color as the tubes or context of the pileus next the tubes. *Fig. 3.*

On dead roots, stumps, etc. of frondose trees in the southern United States.

GANODERMA OREGONENSE Murrill, North American Flora 9<sup>2</sup>:119. 1908.—Sporophore large, stipitate; pileum 14–17<sup>cm</sup> long, 12<sup>cm</sup> broad, 5.5<sup>cm</sup> thick, tumid, upper surface rather strongly convex, hymenophore slightly convex or plane; surface smooth, with a thin

brittle crust, shining as if varnished (laccate), dark reddish brown (seal brown to clove brown, *R* with reddish tinge), sulcate, rings distant on the surface, crowded at the margin, more or less rugose; trama white, cinnamon next the hymenophore, very soft, punky, and yielding like chamois skin, the cinnamon-colored portion firmer; hymenophore of long slender tubes, up to 2–5 cm long, often with a stratified appearance, the strata 3–4 mm and marked off by faint lighter lines, brown, near cinnamon to Mars brown (*R*), firm, woody, tubes angular, 4–5 to a mm., dissepiments thin, entire; spores elliptical to subovate, rounded at the broader end, in age truncate at the smaller end, attached one side of the broader end, wall perforated by numerous short lines of a brownish substance, giving a verrucose appearance to the spore which is really smooth, 11–15×7–8 μ; stem stout, 1–1.5 cm × 3–6 cm, irregular, surface like that of the pileus; trama white, soft like the white part of the pileus, with a radiate, fibrous growth from the middle line and continuing into trama of the pileus. *Fig. 4.*

On dead *Picea sitchensis* near Seaside, and on dead root (of conifer?), Corvallis, Oregon.

**Ganoderma subperforatum** Atkinson, n. sp.—Sporophore medium size, stipitate. Pileus lateral, simple or lobed, subcircular to reniform, convex, brick red to bay, vinaceous cinnamon toward margin, and the margin lighter color when young, laccate, broadly sulcate; spores ovate-cuneate, content brownish, wall thin, very faintly perforate with slender dark lines, which are seen with difficulty, 8–12×5–8 μ. *Fig. 5.*

(Sporophorum stipitatum. Pileo suberoso lignoso, sulcato-rugoso stipiteque laterali, laccato, rubro-castaneo; sporae ovato-cuneatae, membraneo leviter perforato ab lineis brunneis, 8–12×5–8 μ.)

On dead oak wood, Chillicothe, Ohio. Type specimen no. 19560 in herb. Cornell University.

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#### EXPLANATION OF PLATE XIX

Photomicrographs of spores of several species of *Ganoderma*, ocular 12, objective 1.5<sup>mm</sup> oil immersion, Zeiss microscope, plate-holder 370<sup>mm</sup> from object. The photomicrographs were made by the author. The photographs from which the text figures were produced were made by E. J. PETRY under the author's direction.

FIG. 1.—*Ganoderma pseudoboletem* forma *montanum* Atkinson, from plant on fir, Jura Mts., France; some of the spores show the entire conical, hyaline cap at apex; note the dark lines perforating the hyaline wall; the upper right-hand spore is in side view, showing at the lower corner a point where the spore was attached to the sterigma; lower spore slightly out of median focal plane, surface appearing roughened or echinulate.

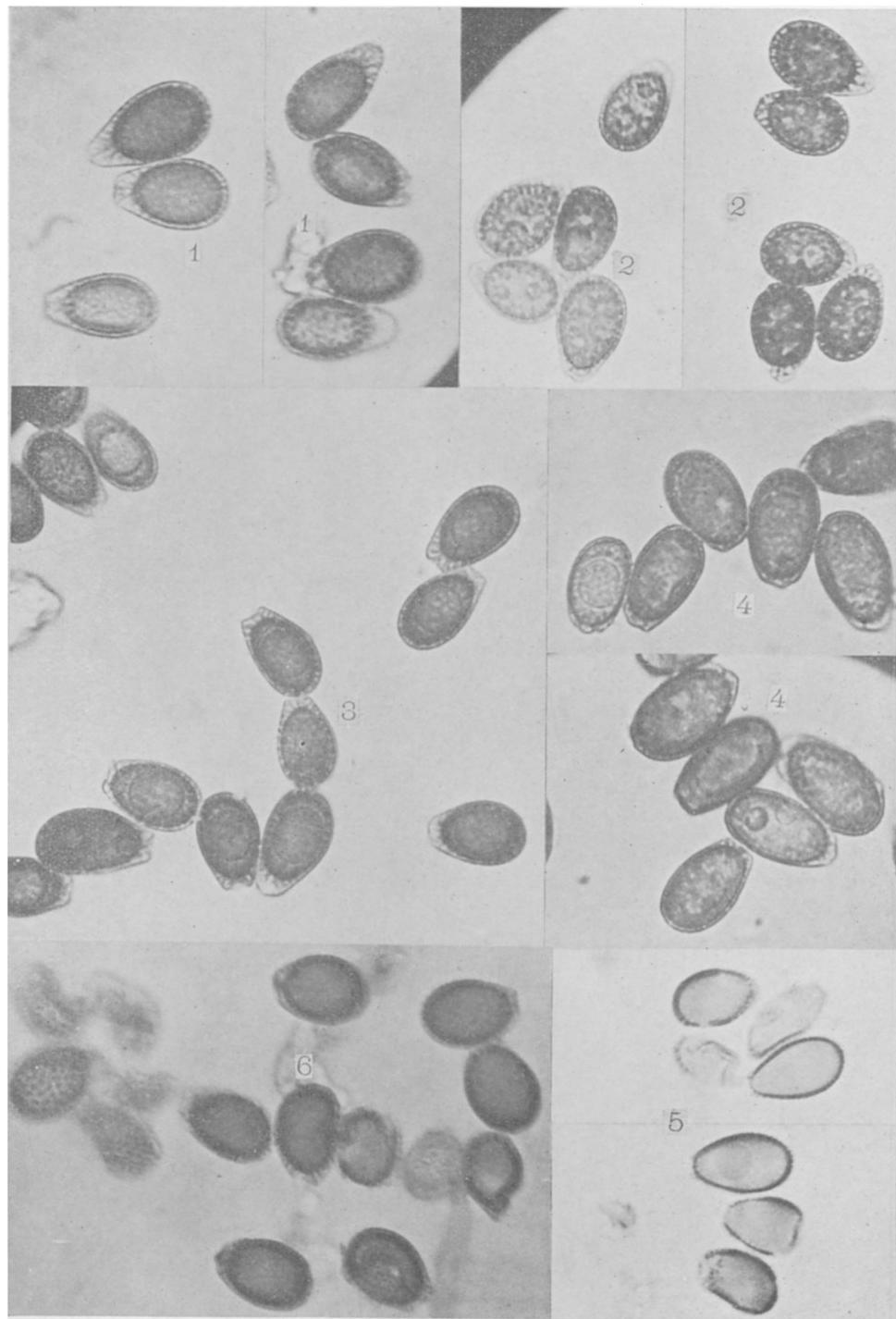
FIG. 2.—*Ganoderma pseudoboletem* forma *tsugae* (Murr.) Atkinson, from plant on hemlock-spruce, Ithaca, N. Y.; a few of the spores show the entire conical cap at the apex; one of the spores of the group in the left is in side view, showing the inequilateral form, and the point where attached to sterigma; note the perforating dark lines in the hyaline wall of the spores; one spore at extreme left slightly out of median focal plane, and these lines appear as echinulations.

FIG. 3.—*Ganoderma curtisii* (Berk.) Murrill; one of the spores at the lower side shows the entire conical cap at apex; this and another one at the left are in side view, showing the inequilateral form; note the perforating dark lines in the hyaline wall; North Carolina plants.

FIG. 4.—*Ganoderma oregonense* Murrill; showing elliptical form of spores, thinner wall, dark perforating lines in wall of spores.

FIG. 5.—*Ganoderma subperforatum* Atkinson, from Ohio; showing cuneate form of spores and faint dark lines in the spore wall, only brought out by boiling in potash solution.

FIG. 6.—*Ganoderma pseudoboletem* typicum, from plant collected in Bois de Boulogne, Paris; most of the spores are out of focus; the dark lines perforating the walls appearing as warts or echinulations, but the spores are really smooth.



ATKINSON on *POLYPORUS LUCIDUS*